



Armed Forces College of Medicine AFCM



DEVELOPMENT OF CVS (I) [FORMATION OF THE CARDIAC LOOP]

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INTENDED LEARNING OBJECTIVES (ILO)



- At the end of this lecture, students should be able to:
 - i. Describe the sequence of events taking place during the prenatal development of the cardiac loop.
 - ii. Discuss the fate of the embryonic structures.
 - iii. Correlate the sinus venosus to its fate.

Key points



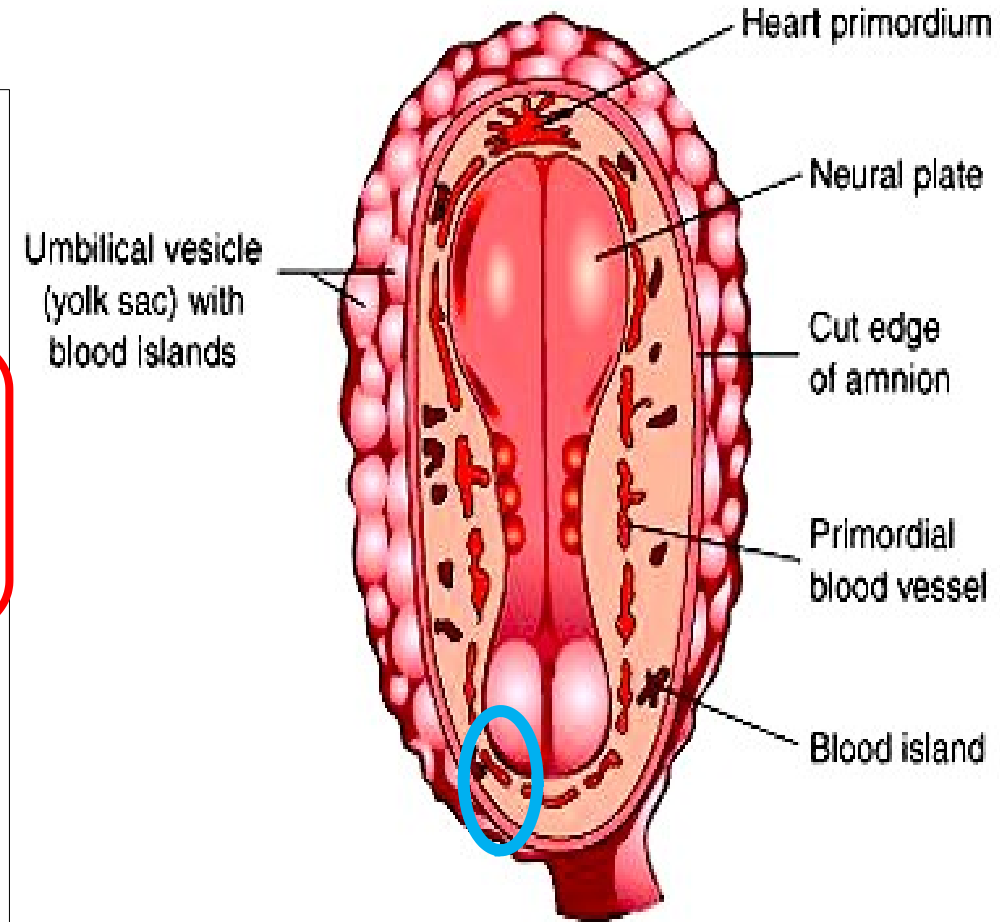
1. Early & later development of the heart
2. 4 changes in the heart tube
3. Fate of the embryonic cardiac loop
4. Changes & fate of sinus venosus

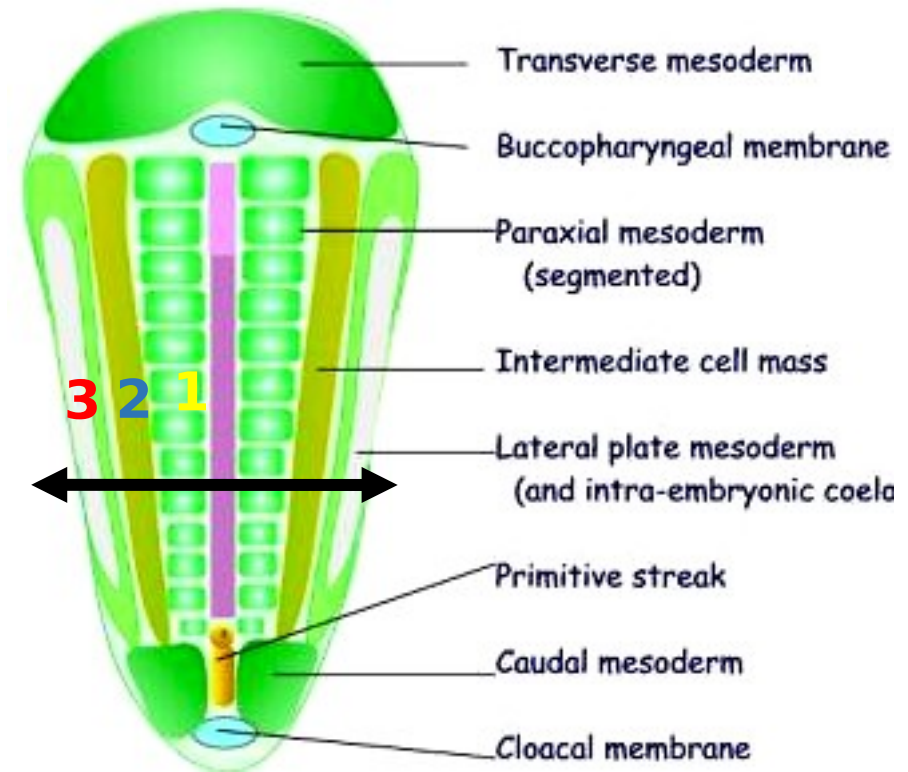
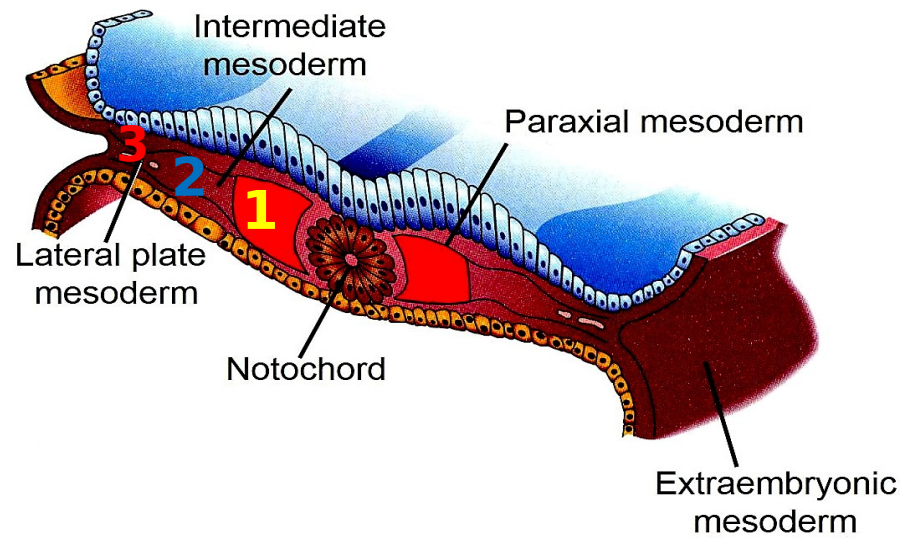
Introduction

♣CVS is the **first** organ system to function in the embryo (to provide nutrition & O₂ for the rapidly growing embryo).

.The primordial heart & vascular system **begin** to develop in **3rd week**. The heart begins to **beat** during **4th week**.

-CVS is totally **mesodermal** in origin. (*Lateral plate mesoderm*)



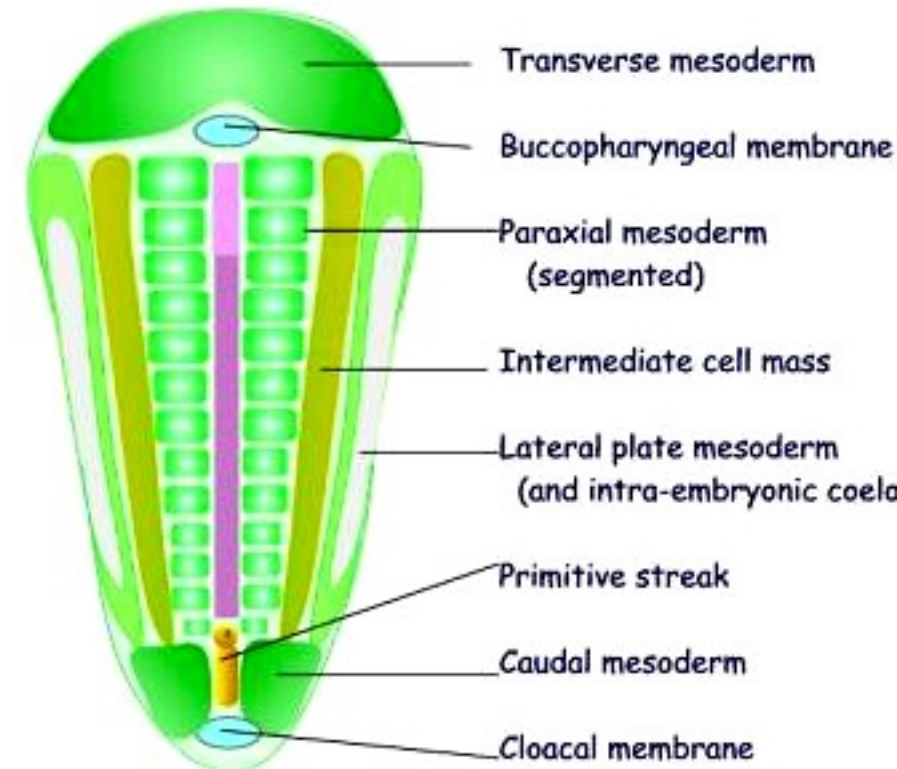
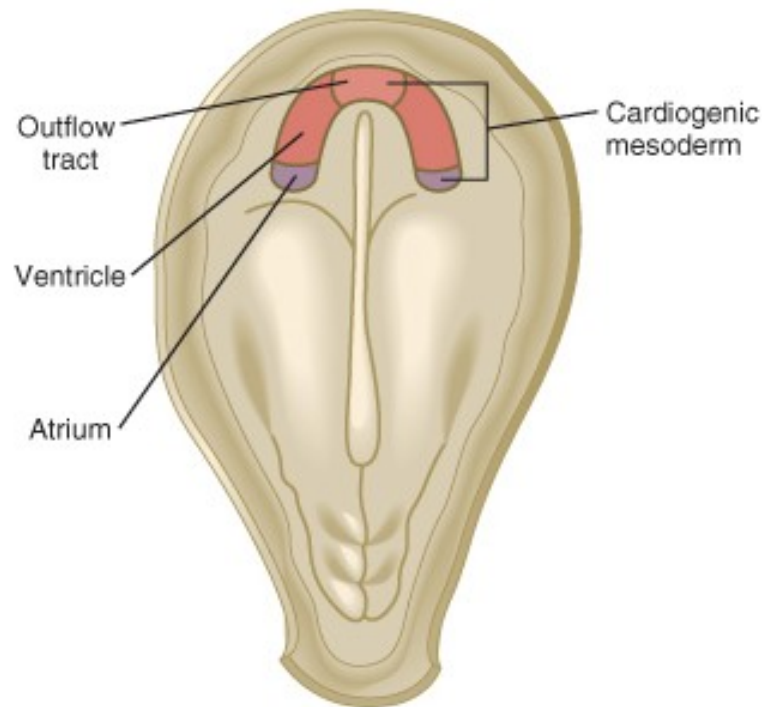
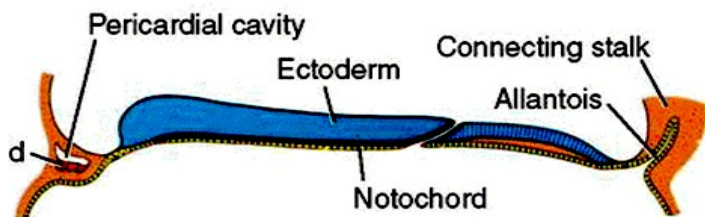
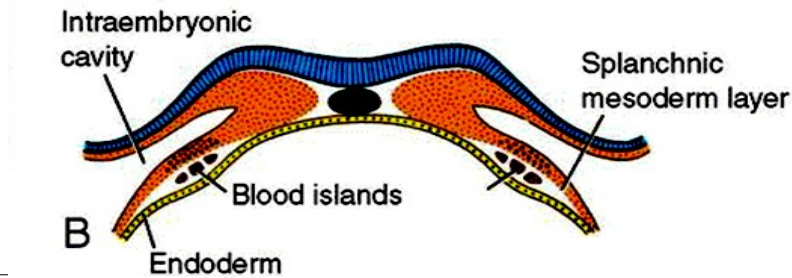


Development of the heart

♣ Early development:

It develops from the splanchnic mesoderm which lies in front of the buccopharyngeal membrane, ventral to the pericardial sac (**cardiogenic area**).

- The angiogenic cells in this area form 2 endocardial heart

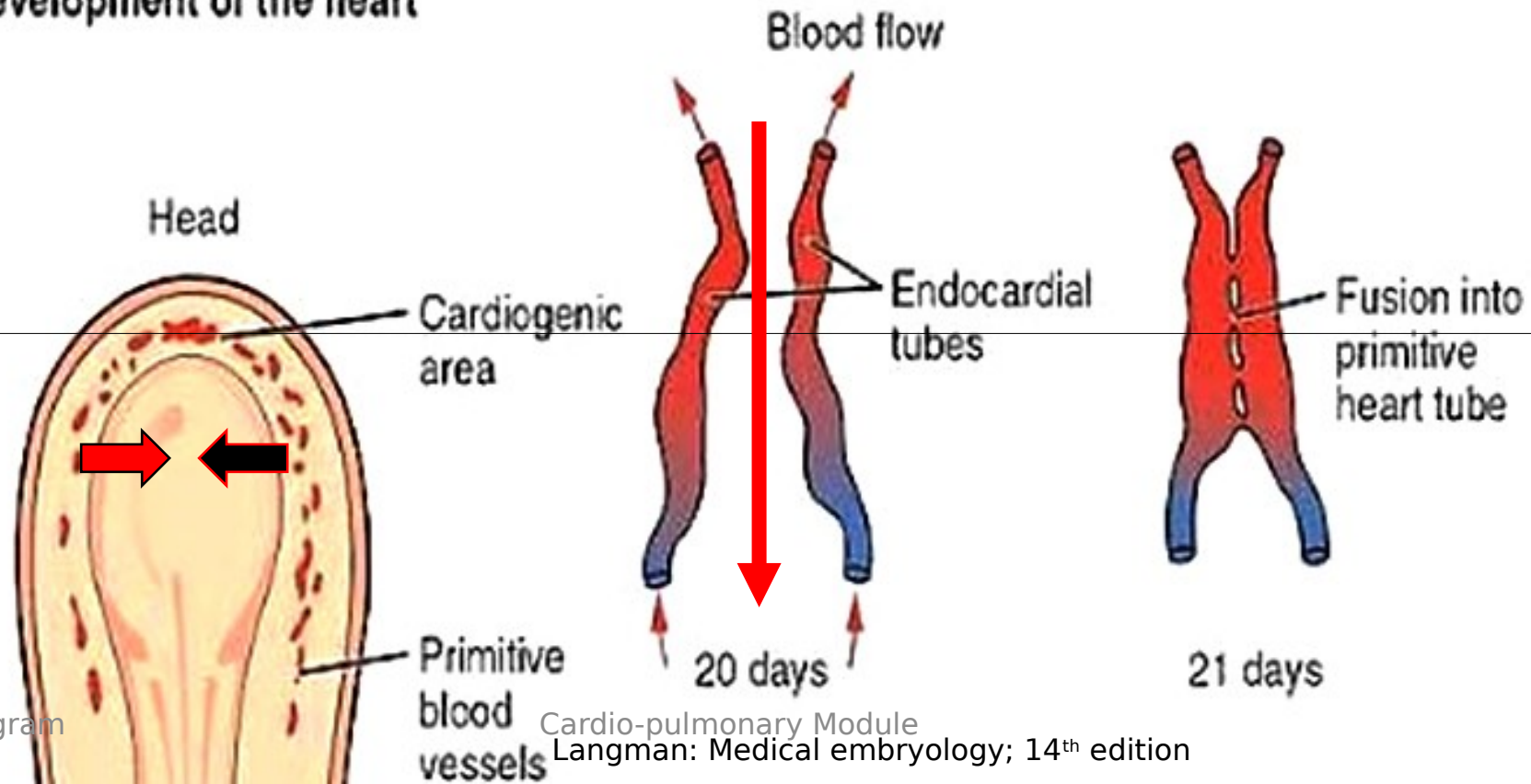


◆ **Later development of the heart:**

.Lateral embryonic folding ⇒ The 2 endothelial heart tubes approach each other & fuse to form a single heart tube.

.Fusion of the heart tubes begins at the cranial end & extends caudally.

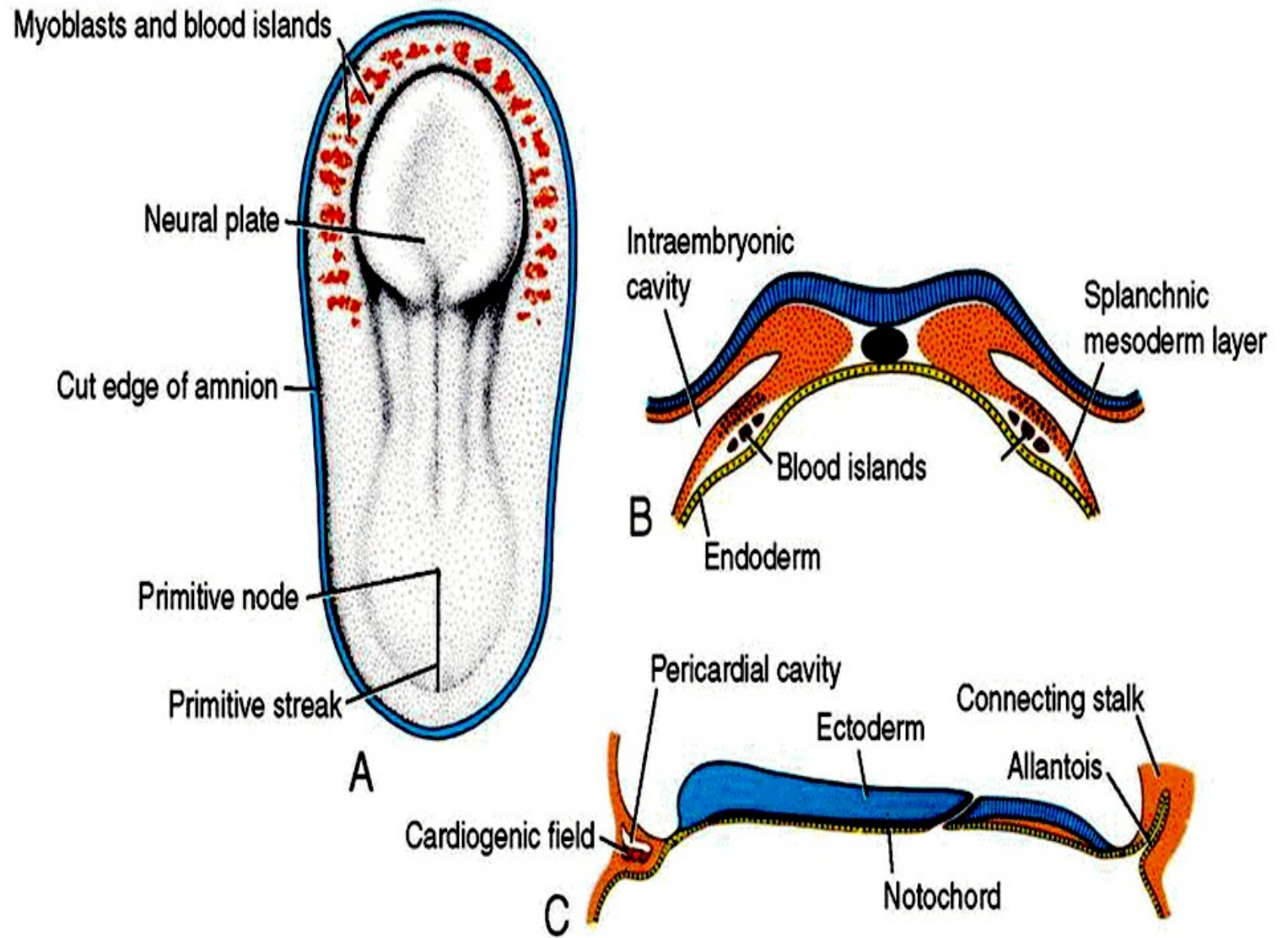
Development of the heart

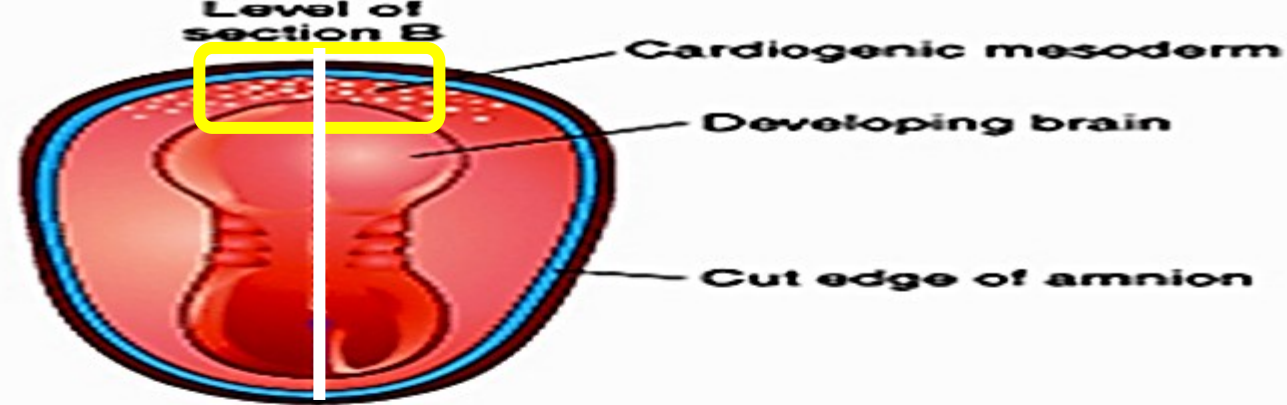


Note
that

-Pericardial sac develops from the transverse cranial part of the U-shaped **intra-embryonic coelom** dorsal to the cardiogenic plate.

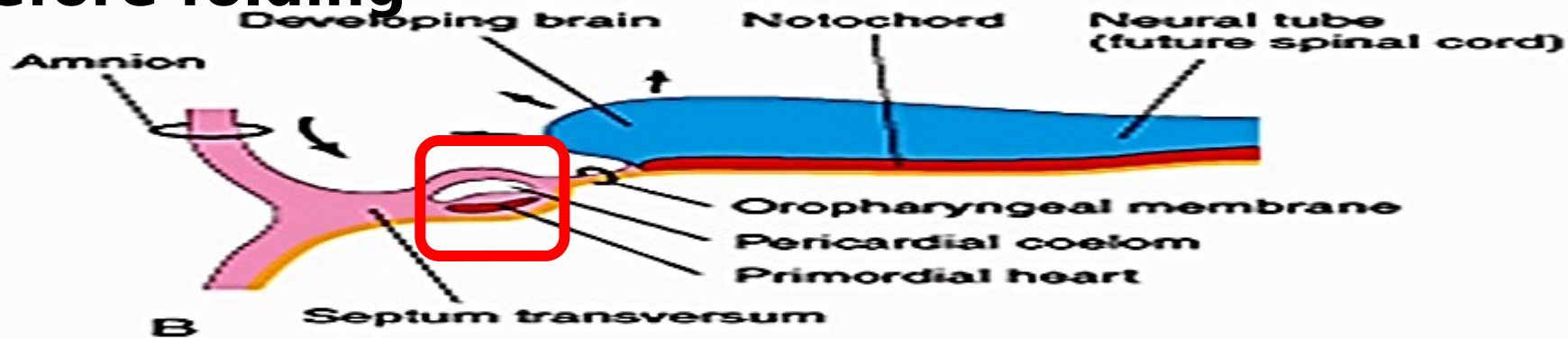
-It is situated between the septum transversum (cranially) & the oropharyngeal membrane (caudally) *before folding.*



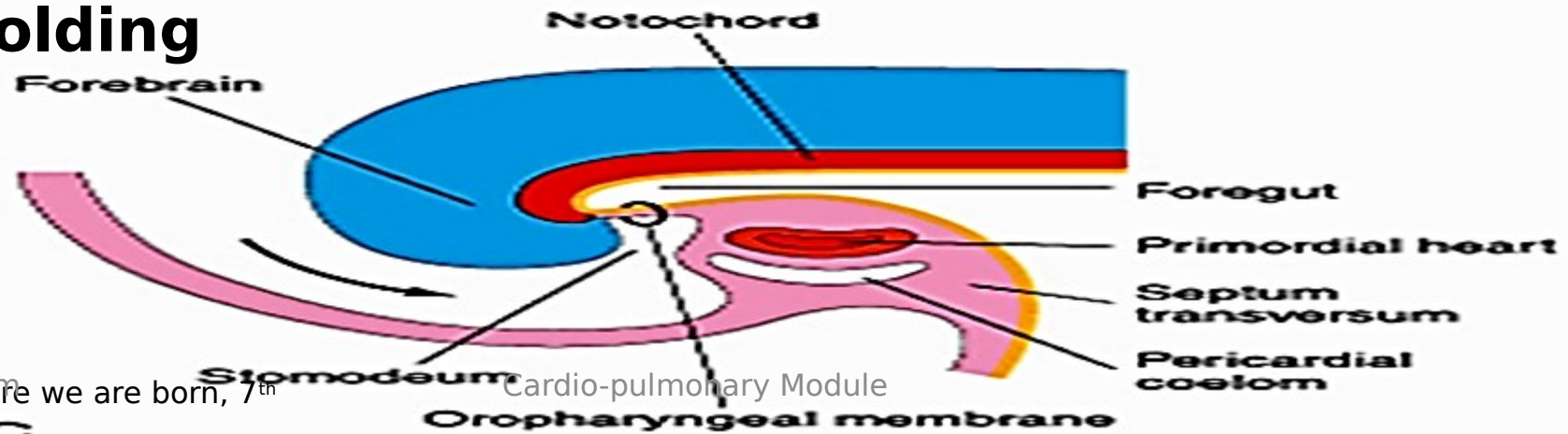


Pericardial sac & primordial heart

Before folding



After folding



.Cranial (head) folding ⇒ Heart

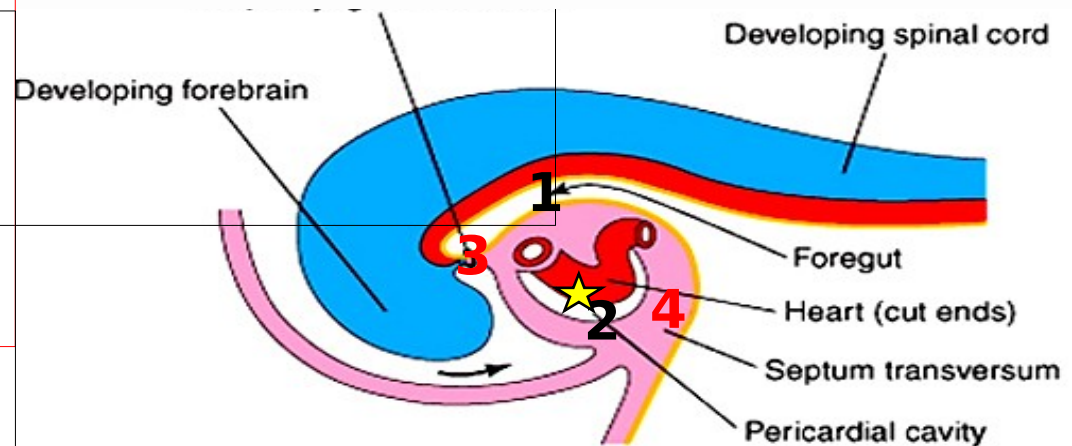
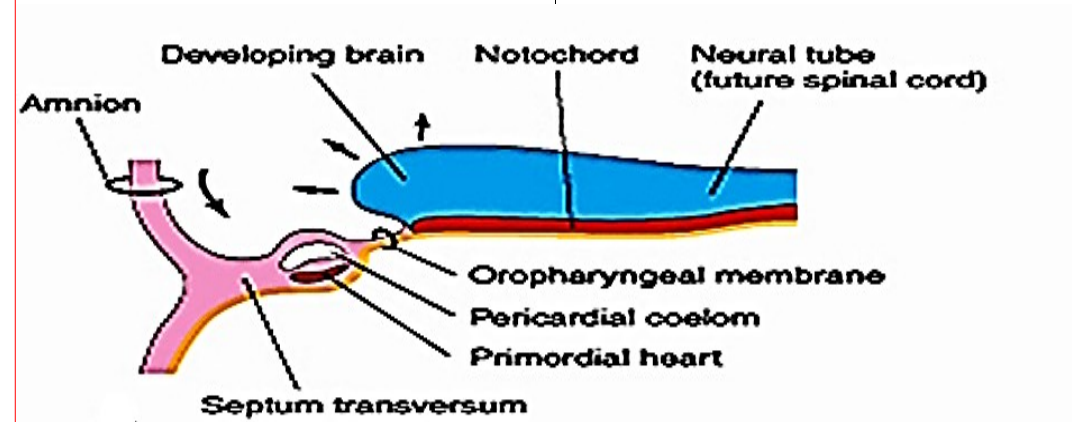
tube becomes:

1.Ventral to the foregut.

2.Dorsal to pericardial sac.

3.Caudal to oropharyngeal membrane (Mouth).

Myocardium develops from splanchnic mesoderm (Diaphragm), situated between the pericardial sac & the endocardial tube



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- Endocardium is derived from endocardial heart tube.**
- Myocardium is derived from the myoepicardial mantle.**
- Epicardium is derived from the visceral layer of pericardial sac.**

Quiz



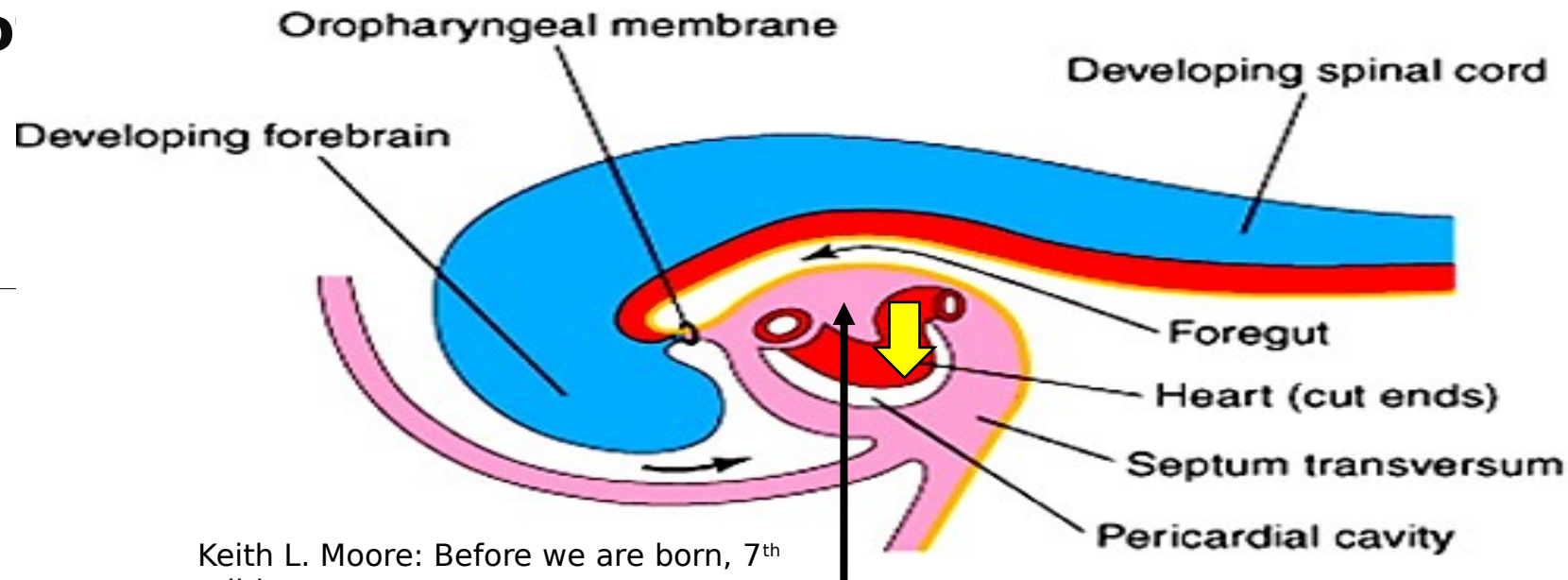
■ Mention true or false:

1. CVS develops completely from paraxial mesoderm.
2. From which primordium does myoepicardial mantle develops?
 - a. Splanchnic lateral plate ^{*}mesoderm
 - b. Paraxial mesoderm
 - c. Somatic lateral plate mesoderm
 - d. Intermediate cell mass
 - e. Endoderm of yolk sac

◆ **Changes of the heart tube: 4 changes**

I-The endocardial heart tube invaginates the pericardial sac from its dorsal aspect dividing it into a visceral layer (epicardium) & a parietal layer.

-A double-layered fold called **dorsal mesocardium is attached to the dorsum of the tube. Later, the dorsal mesocardium becomes absorbed forming the transverse sinus o**



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Mesocardium

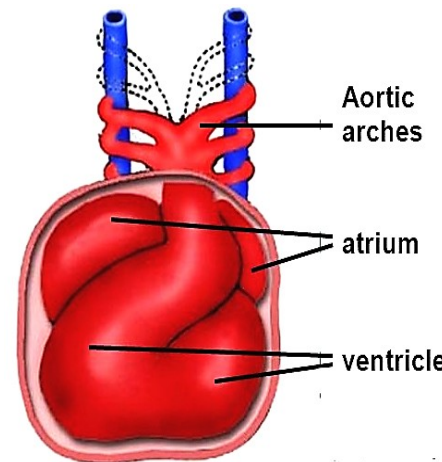
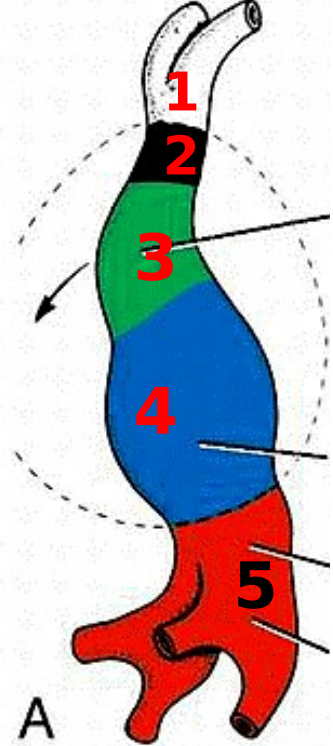
11.5 chambers appear as dilatations (separated by constrictions) in the heart tube. In a cranio-caudal order, they are:

1. Truncus arteriosus.
2. Bulbus cordis (Conus cordis).
3. Primitive or common ventricle.
4. Primitive or common atrium.
5. Sinus venosus (*a body & 2 horns*).

-Truncus arteriosus (TA) is continuous cranially with the aortic sac from which the pharyngeal arch arteries arise & pass to the dorsal aortae.

-Sinus venosus receives (on each side) 3 veins: Umbilical vein (from the placenta), vitelline vein (from yolk sac) & common cardinal veins (from body of embryo).

.The arterial end (TA) & venous end (sinus venosus) of the heart are **fixed** by the pharyngeal arches & the

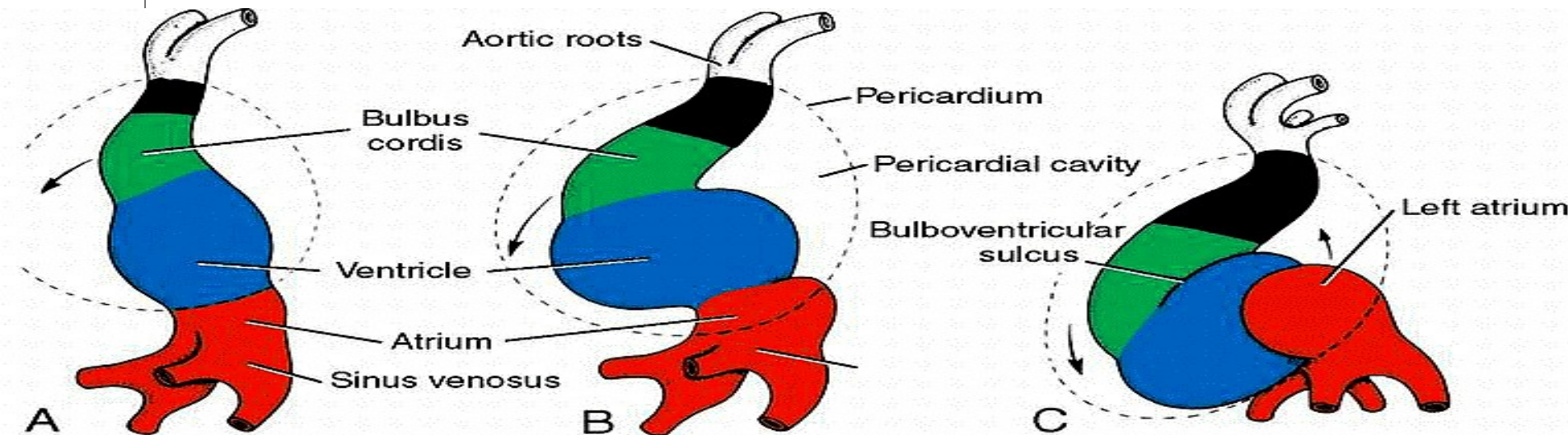


III. Elongation and bending of the heart tube: *Cardiac loop*

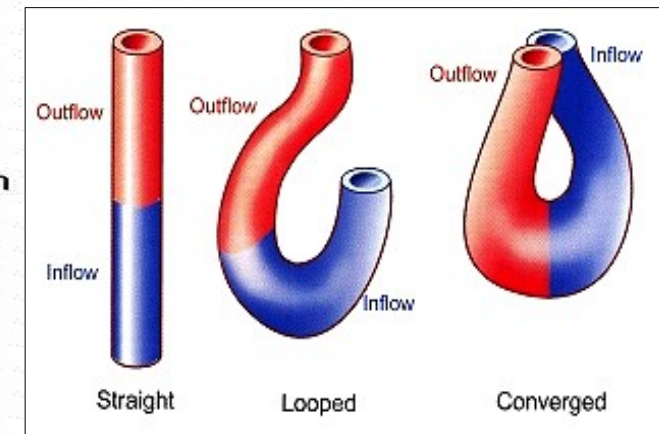
Waheeb

-Causes of bending:

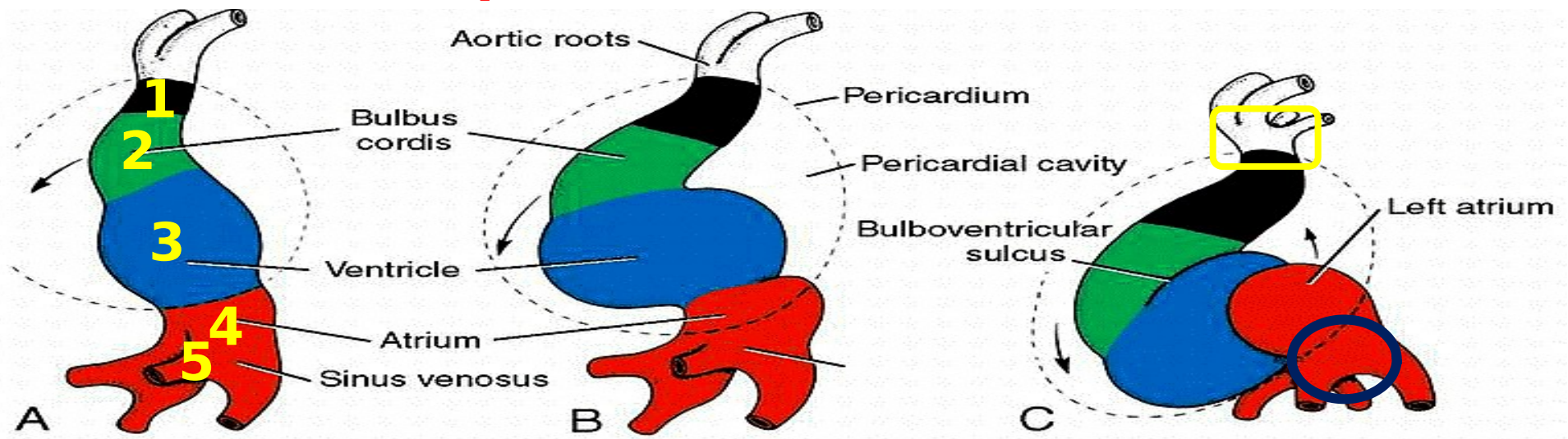
1. Elongation of the heart tube, while its 2 ends are fixed.
 2. Disproportionate growth between heart tube & pericardial sac.
 3. Disproportionate growth between different parts of the heart tube.
- Because the bulbus cordis & the ventricle grow faster than other regions, the heart bends (to the right) on itself, forming a U-shaped **bulbo-ventricular loop**. *Convex to the right*



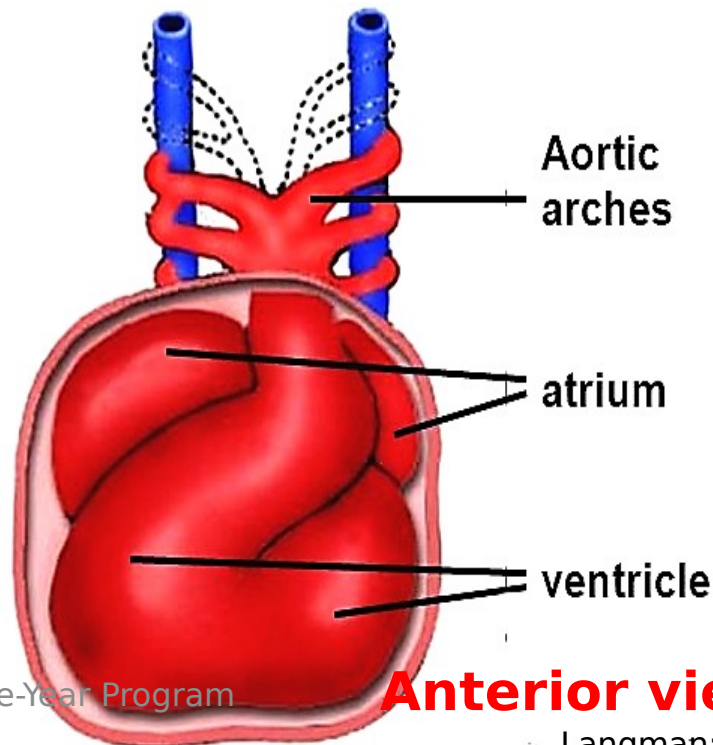
atrium & sinus



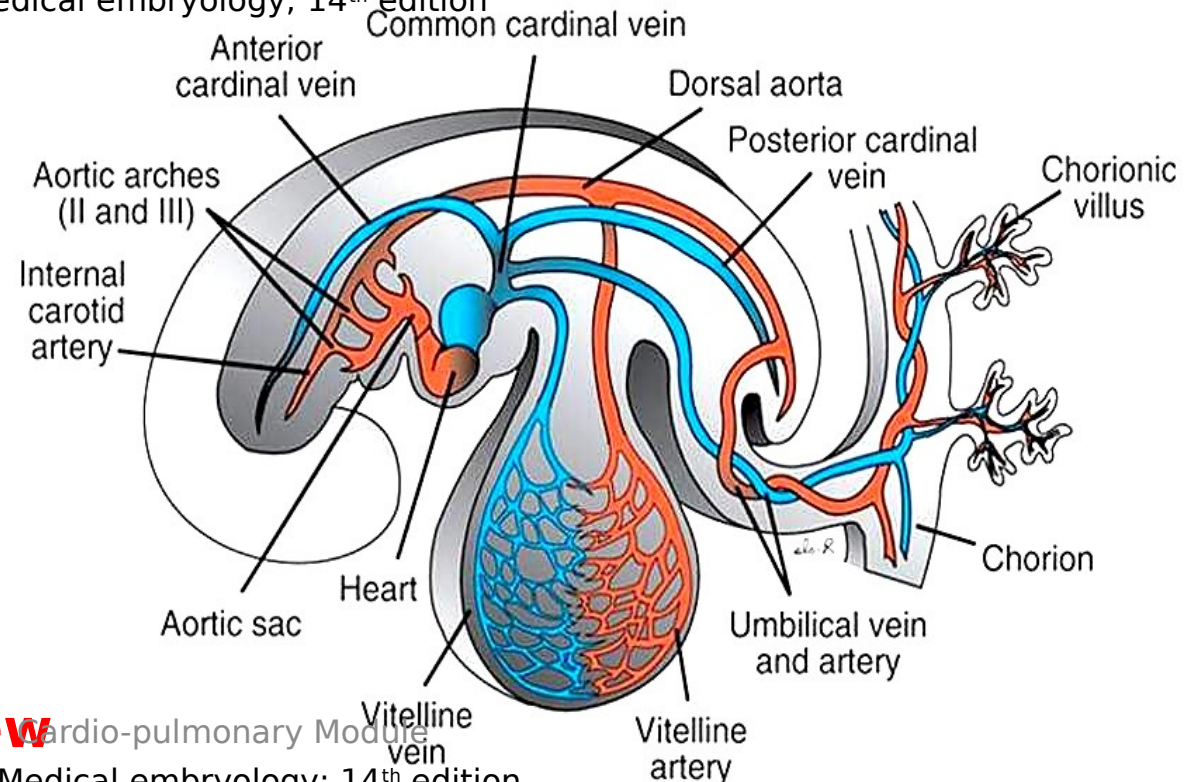
Development of cardiac chambers



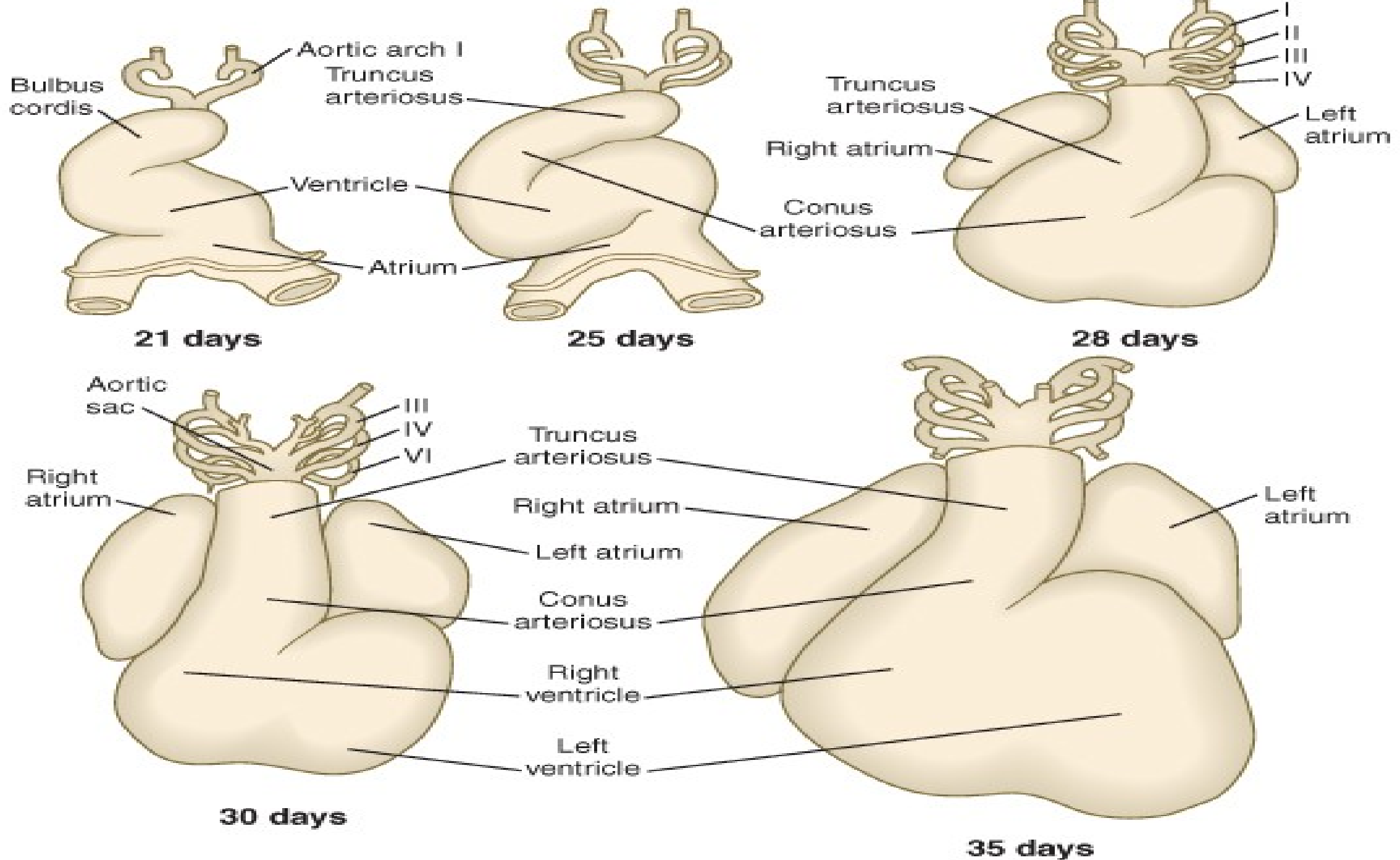
Langman: Medical embryology; 14th edition



Anterior view

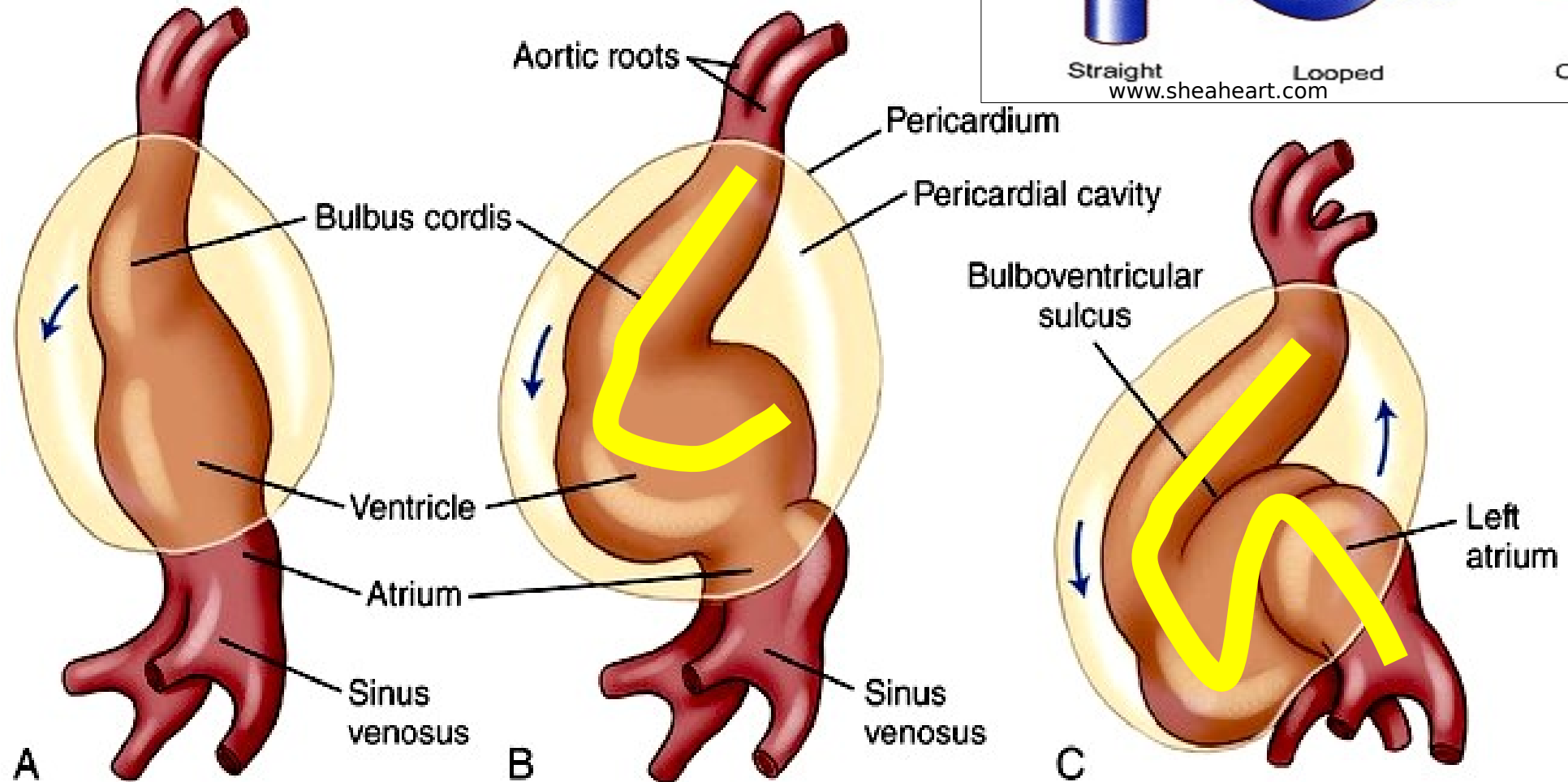
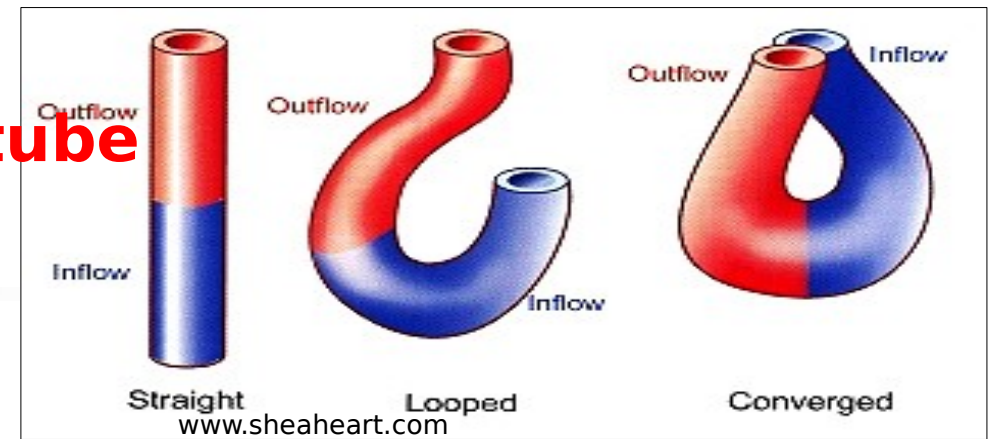


Langman: Medical embryology; 14th edition



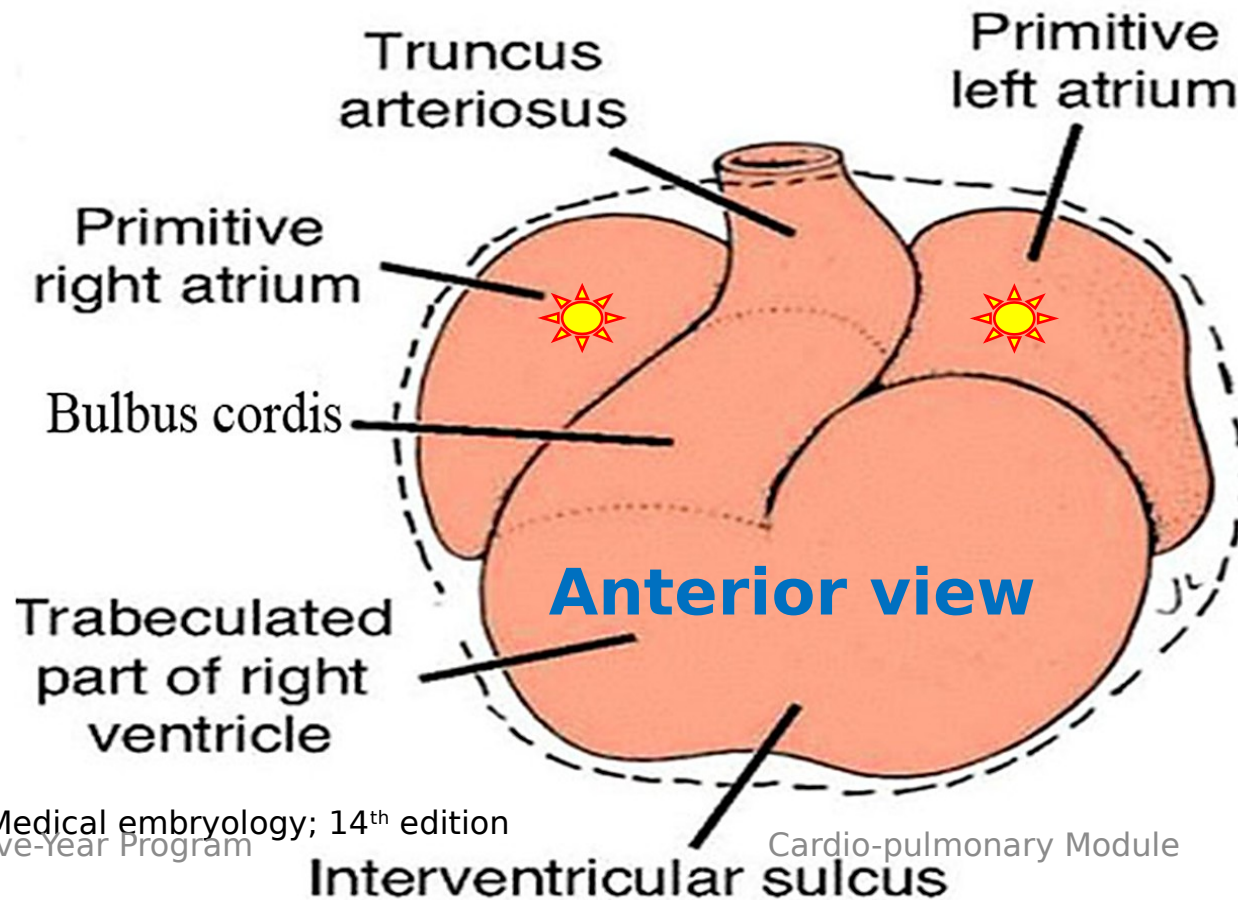
Elongation and bending of the heart tube

Formation of the cardiac loop



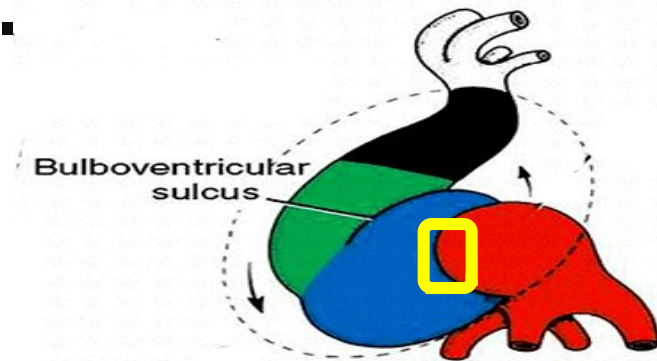
■The constriction between the atrium & the ventricle is slightly elongated forming the atrio-ventricular canal.

-The atrium expands transversely, bulging on either side of the bulbus cordis.

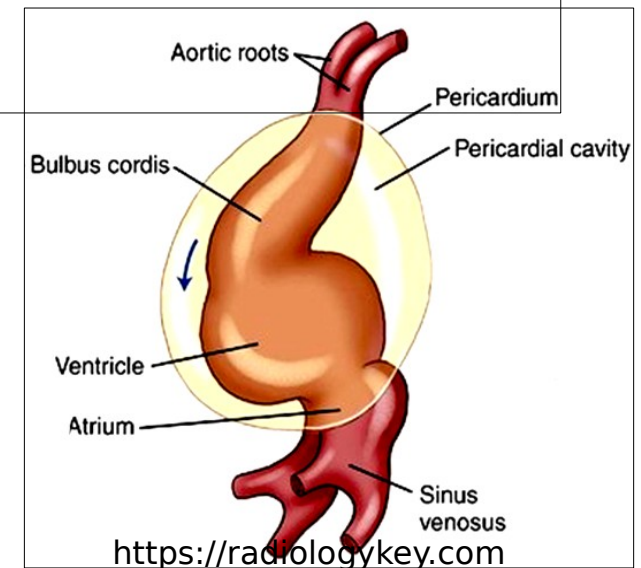


Langman: Medical embryology; 14th edition
New Five-Year Program

Cardio-pulmonary Module



Langman: Medical embryology; 14th edition

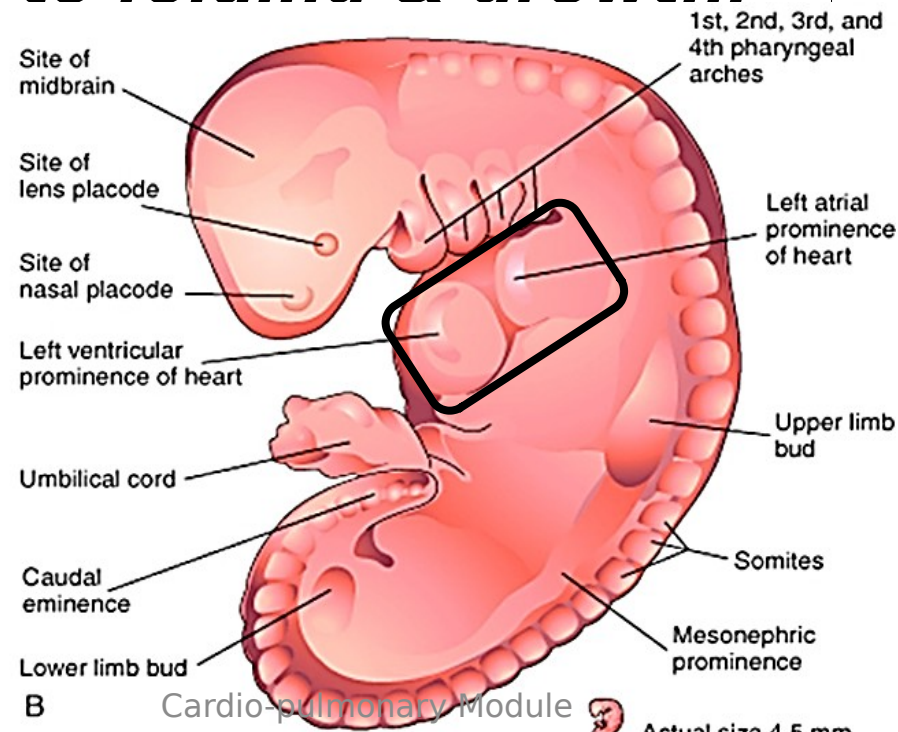
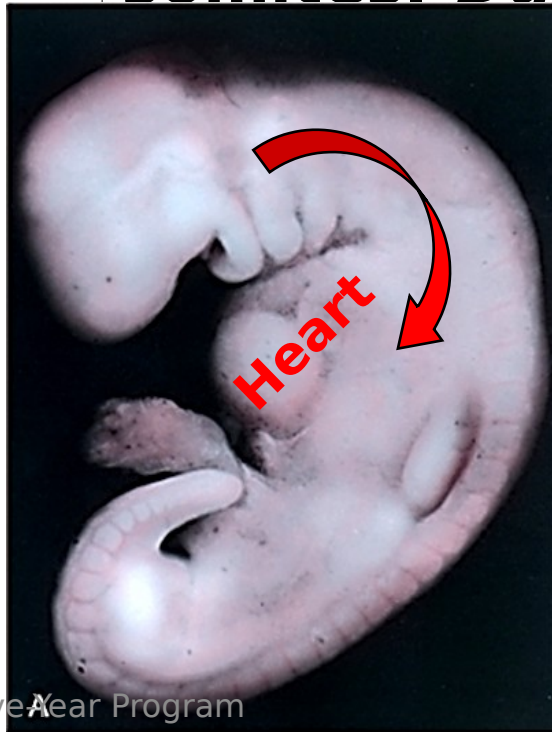


<https://radiologykey.com>

Caudal migration

IV.Caudal migration:

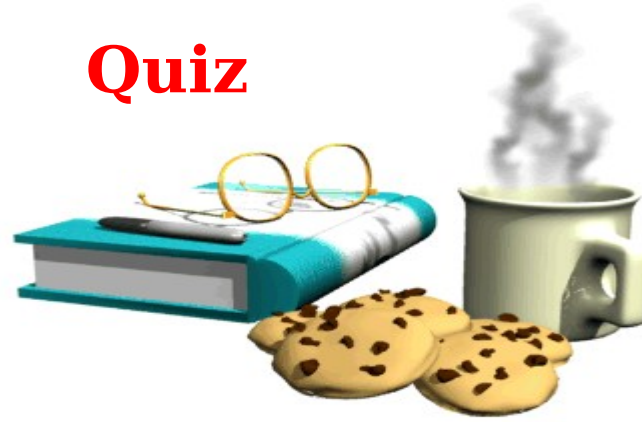
The heart & pericardium migrate caudally from the level of 3rd - 4th somites to the level of 17th - 20th somites. *Due to folding & growth.*



◆ **Fate of the embryonic cardiac loop:** *Derivatives of cardiac chambers*

1. **Truncus arteriosus** ⇒ **Ascending aorta & pulmonary trunk.**
2. **Bulbus cordis (Conus cordis)** ⇒ Smooth outflow parts of both ventricles: **Infundibulum (conus arteriosus)** of right ventricle & **aortic vestibule** of left ventricle.
3. **Primitive ventricle** ⇒ Rough (trabeculated) inflow parts of both ventricles.
4. **Primitive atrium** ⇒ **Rough (trabeculated) parts of both atria: Right auricle & left auricle.**
5. **Sinus venosus** ⇒ **Smooth part of right atrium (sinus venarum) & coronary venous sinus.**
- . **Smooth part of the left atrium develops from the absorbed pulmonary veins.**

Quiz



■ Mention true or false.

1. Bulbus cordis is the most cranial of the cardiac chambers.

2. Primitive ventricle gives rise to conus arteriosus.

3. As a result of cranial folding, heart becomes ventral to the pericardial sac.

4. Sinus venosus gives smooth posterior parts of both right & left atria.

◆Sinus venosus:

-Initially, the sinus venosus opens into the center of dorsal wall of the primitive atrium.

-It is formed of a body & 2 horns (right & left).

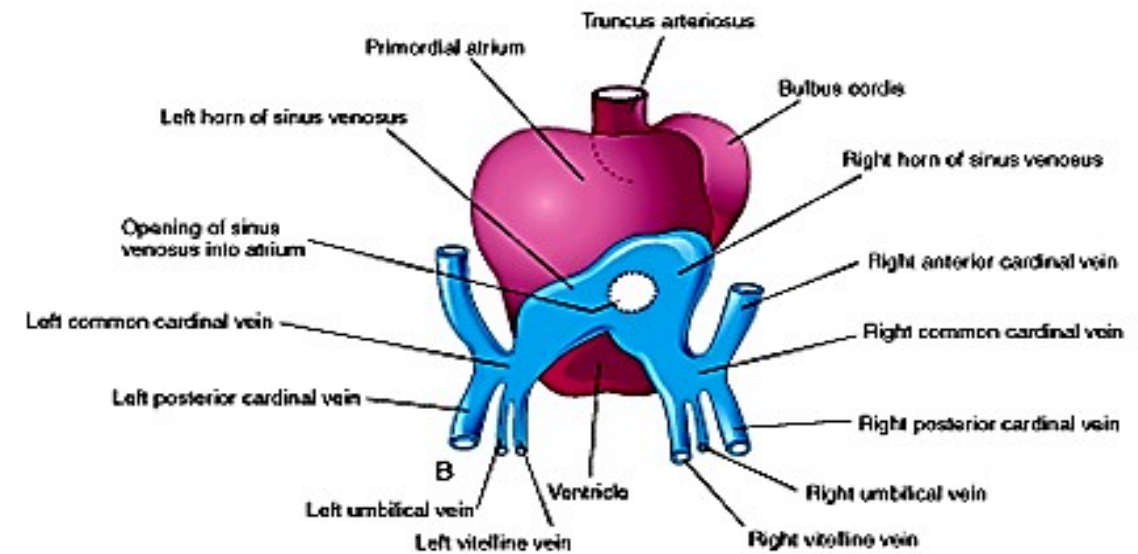
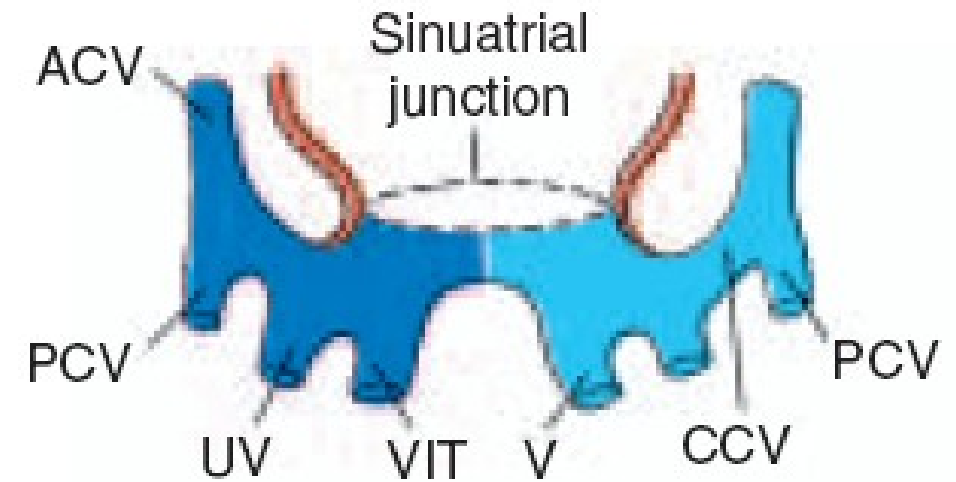
-Each horn receives 3 veins:

1.Umbilical vein from the chorion (**placenta**).

2.Vitelline vein from the umbilical vesicle (**yolk sac**).

3.Common cardinal vein from body of embryo.

.The opening between the sinus venosus & the atrium is a vertical slit. Its edges are called the right

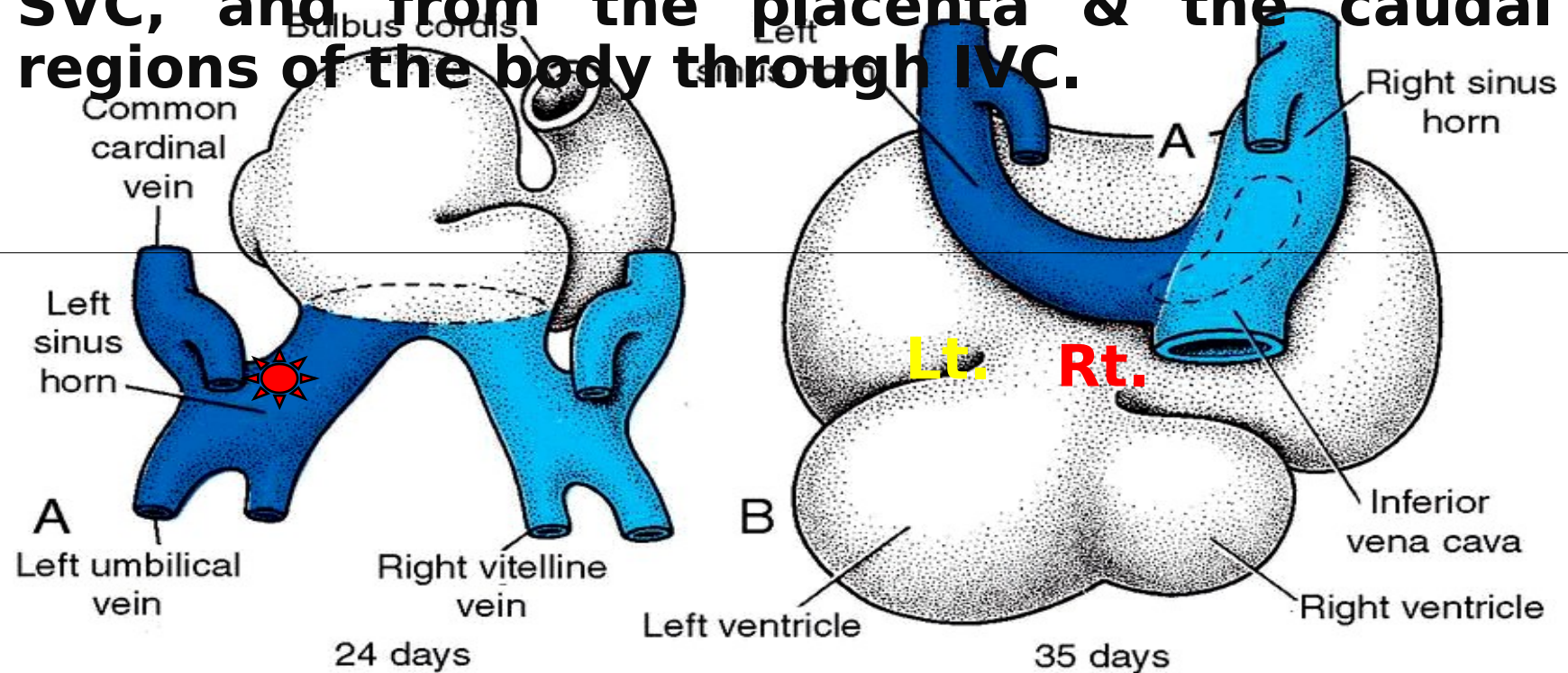


Posterior view

■ **Changes in sinus venosus:**

-By the end of 4th week, the **right sinus horn** becomes larger than the left sinus horn (due to left to right shunt of the venous blood) ⇒ Sinu-atrial orifice moves to the right.

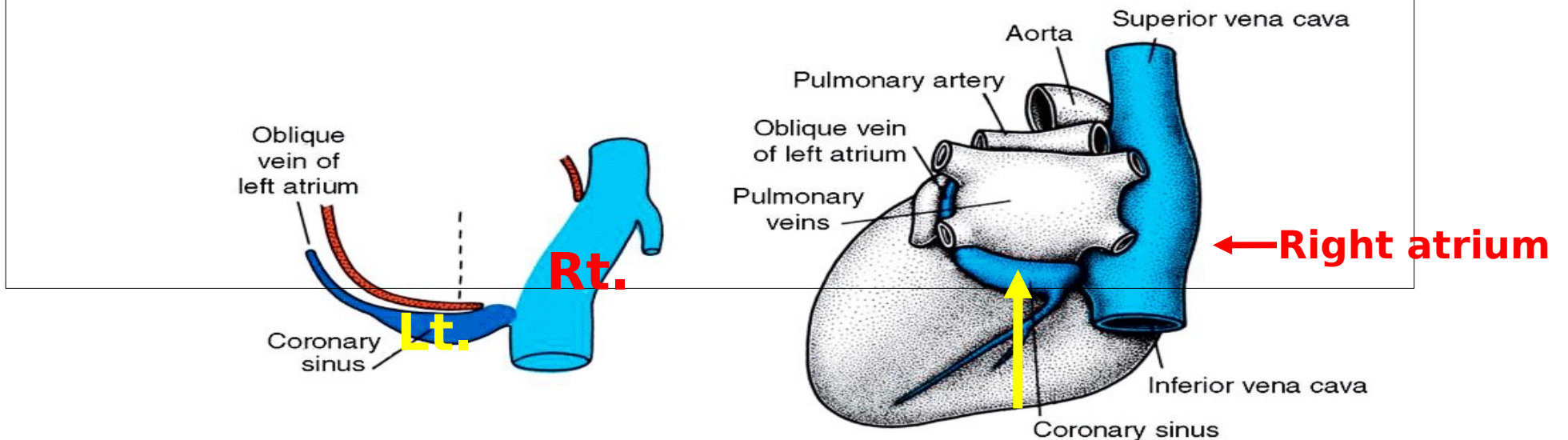
-As the right sinus horn enlarges, it receives all the blood: From the head & neck through SVC, and from the placenta & the caudal regions of the body through IVC.



■ Fate of sinus venosus:

A] **Right horn** is incorporated into the developing right atrium \Rightarrow Smooth posterior part of right atrium (**sinus venarum**).

B] **Body & left horn** \Rightarrow Coronary venous sinus.



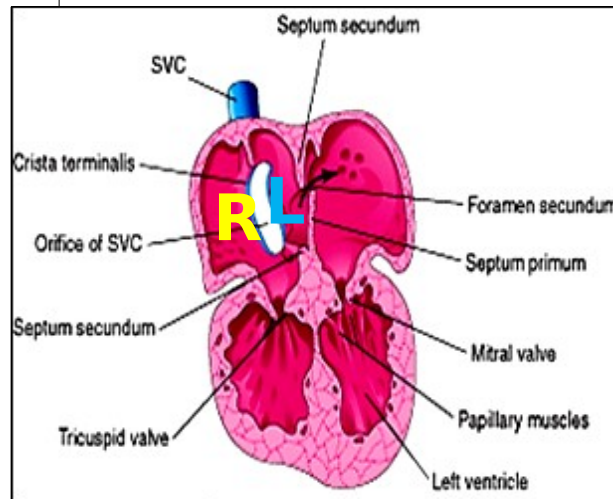
-Fate of sinu-atrial (venous) valves:

-Right valve ⇒ 3 derivatives:

Upper part of the valve → **Crista terminalis.**

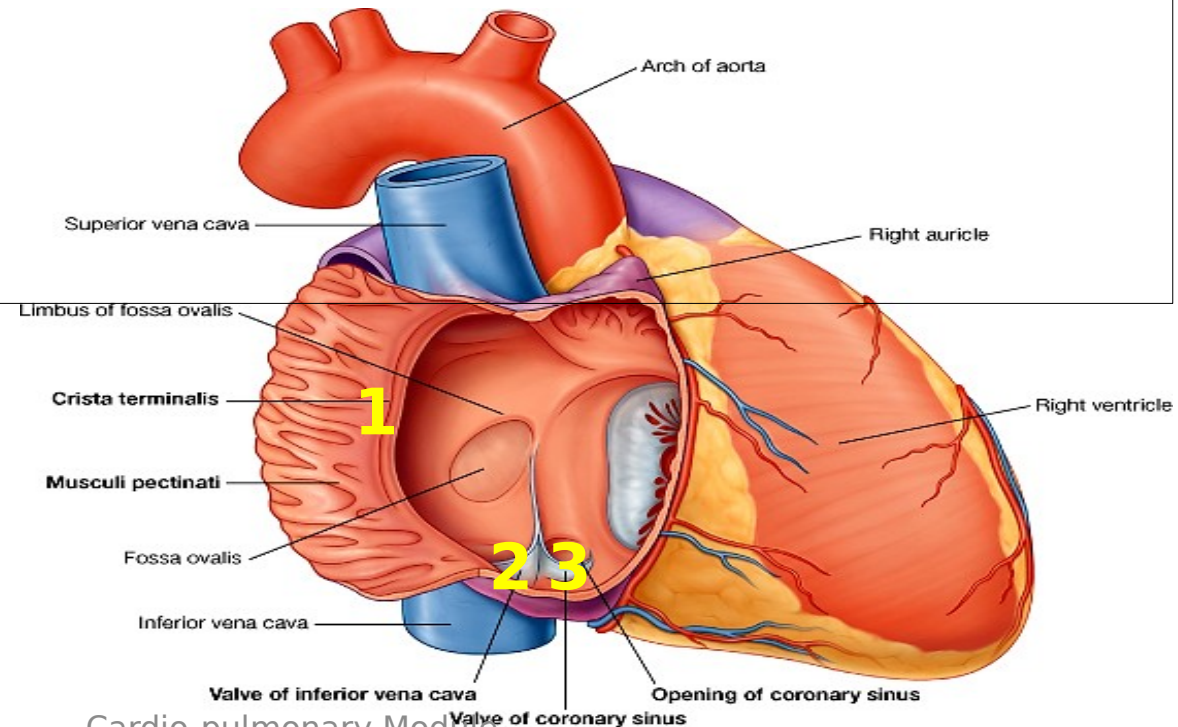
Lower part of the valve → **Valve of IVC & valve of the coronary sinus.**

-Left valve is incorporated into interatrial septum.



Keith L. Moore: Before we are born, 7th edition

New Five-Year Program



Cardio-pulmonary Module

Gray's anatomy for students, 3rd Edition

Quiz



■List the derivatives of sinus venosus.

Lecture Summary



Heart

- **Mesodermal in origin.** *Lateral plate mesoderm*

. It invaginates the pericardial sac (*From behind*).

- **4 to develop 5 chambers heart tube:**

1. It invaginates the pericardial sac (*From behind*).

2. It develops 5 chambers.

3. It elongates & bends ⇒ **Cardiac loop.**

4. It migrates caudally.

5 chambers appear as dilatations (separated by constrictions) in the heart tube. Remember their fate

SUGGESTED TEXTBOOKS



1. Keith L. Moore: Before we are born, essentials of embryology and birth defects; 7th edition.
2. Langman: Medical embryology; 14th edition.
3. Web sites: <https://studentconsult.inkling.com/>
<https://www.clinicalkey.com/student>

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